

## IMAGE DATA PROCESSING DEVICE

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to an image data  
5 processing device and, more particularly, to an image data  
processing device that reduces the amount of intermediate  
data used for generating print data from page description  
language data.

#### 2. Description of Related Art

10 It is known in the art to perform processing to  
generate intermediate data (interim coding) and to store, in  
memory, the intermediate data during the expansion into  
print data (bitmap data) from page description language  
(PDL) data that has been received from a device such as a  
15 personal computer (PC).

During this process, it is highly likely that the  
memory will become full, particularly if there is a large  
amount of intermediate data. For that reason, techniques  
are known in the art for reducing an amount of the  
20 intermediate data, as disclosed in Japanese patent-  
application publication (kokai) No. 2001-270164.

### SUMMARY OF THE INVENTION

However, a method disclosed in Japanese patent-  
application publication (kokai) No. 2001-270164 subjects  
25 part of the data to enlargement processing during the

generation of the intermediate data. Accordingly, the reduction in an amount of the intermediate data cannot be performed sufficiently.

5 In view of the above-described drawbacks, it is an objective of the present invention to provide an image data processing device and an image forming apparatus that can reduce the intermediate data to suppress any inflation of the intermediate data and suppress pressure on the memory.

10 In order to attain the above and other objects, the present invention provides an image data processing device. The image data processing device includes an interpreter portion and a rasterize portion. The interpreter portion obtains page description language data that includes image data of a source image and image-size specifying data of both the source image and a device image. The interpreter portion generates intermediate data based on the image data of the source image and the image-size specifying data. The rasterize portion generates image data of the device image in an output memory based on the intermediate data. If the 15 image-size specifying data specifies enlargement from the size of the source image to the size of the device image, the interpreter portion generates the intermediate data that includes intermediate image data and enlargement ratio data. The intermediate image data is the same data as the image data of the source image. The enlargement ratio data 20 25

specifies enlargement ratios from the size of the source image to the size of the device image.

The present invention also provides an image forming apparatus. The image forming apparatus includes an image data processing device and a printing device. The image data processing device includes an interpreter portion and a rasterize portion. The interpreter portion obtains page description language data that includes image data of a source image and image-size specifying data of both the source image and a device image. The interpreter portion generates intermediate data based on the image data of the source image and the image-size specifying data. The rasterize portion generates image data of the device image in an output memory based on the intermediate data. If the image-size specifying data specifies enlargement from the size of the source image to the size of the device image, the interpreter portion generates the intermediate data that includes intermediate image data and enlargement ratio data. The intermediate image data is the same data as the image data of the source image. The enlargement ratio data specifies enlargement ratios from the size of the source image to the size of the device image. The printing device prints, on a medium, the device image in accordance with the image data of the device image.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the invention will become more apparent from reading the following description of the preferred embodiments taken in connection with the accompanying drawings in which:

5           Fig. 1 is a block diagram of the configuration of a print system provided with a host computer and a printer according to an embodiment of the present invention;

          Fig. 2 is an explanatory diagram showing the steps performed by an interpreter portion and a rasterize portion;

10           Fig. 3 is an explanatory diagram of data structure of intermediate data;

          Fig. 4 is a flowchart showing the steps of intermediate data generation processing by the interpreter portion;

15           Fig. 5(a) is an explanatory diagram of an example of PDL data and specifically showing an image specifying section;

          Fig. 5(b) is an explanatory diagram of an example of PDL data and specifically showing a palette specifying section;

20           Fig. 5(c) is an explanatory diagram of an example of PDL data and specifically showing a clip command;

          Fig. 6(a) is an explanatory diagram of image data of an image source;

25           Fig. 6(b) is an explanatory diagram showing expansion

of the image source in accordance with scaling data;

Fig. 7(a) is an explanatory diagram showing a general procedure to obtain an expansion multiplier array when expanding an image source size to a device image size;

5        Fig. 7(b) is an explanatory diagram showing a specific example of the procedure shown in Fig. 7(a);

Fig. 8(a) is an explanatory diagram of an image source in clip processing;

10       Fig. 8(b) is an explanatory diagram showing a device image and a clip rectangle in a device page area;

Fig. 8(c) is an explanatory diagram showing a corresponding area of the image source that corresponds to a clipped area of the device image;

15       Fig. 8(d) is an explanatory diagram showing the image source after clipping;

Fig. 9 is an explanatory diagram showing a specific method of the clip processing;

20       Fig. 10(a) is an explanatory diagram showing a device image and a device page area in which an inside area of the device image is shown as a shaded area; and

Fig. 10(b) is an explanatory diagram showing an inside area (shaded area) of the image source that corresponds to the inside area of the device image.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

25       An image data processing device according to a

preferred embodiment of the present invention will be described while referring to the accompanying drawings.

Fig. 1 shows a configuration of a print system that is provided with a printer 1 and a host computer 2 that is  
5 connected to the printer 1.

The host computer 2 is an ordinary personal computer that is connected to the printer 1. The host computer 2 has printer driver software and application software installed therein. The application software creates drawing data.  
10 The printer driver software operates in accordance with a print request from the application software to convert the drawing data into page description language (PDL) data that can be interpreted by the printer 1. The host computer 2 then sends the PDL data to the printer 1.

15 The printer 1 is provided with an interpreter portion 20, a rasterize portion 30, and a print engine 40.

The interpreter portion 20 is configured of a computer system provided with a CPU 21, ROM 22, RAM 23, an input-output device (I/O) 24, and a bus line 25 connecting  
20 together these components. The CPU 21 receives the PDL data from the host computer 2 by operating a program stored in the ROM 22, subjects it to processes shown as Steps S10 through S30 in Fig. 2 (Step is hereinafter referred to as "S"), such as an enlargement/reduction processing (S10), a  
25 rotation processing (S20), and an intermediate data storing

processing (S30), then generates intermediate data (to be described later) for output to the rasterize portion 30.

The rasterize portion 30 is configured of an application-specific integrated circuit (ASIC), for example, and is provided with a drawing memory 32. The rasterize portion 30 performs processing such as that shown as S40 through S60 in Fig. 2. In other words, it acquires the intermediate data from the RAM 23 of the interpreter portion 20 through the I/O 24, then generates device multivalued page data into the drawing memory 32, based on the intermediate data (S40). Then, the page data in the drawing memory 32 is subjected to UCRGCR (under color removal and gray component replacement) processing to adjust the black level thereof (S50). The page data is subsequently binarized through half-tone processing according to well-known dither method (S60). The rasterize portion 30 outputs video data to the print engine 40, based on the data processed by the above-described method.

The print engine 40 is a laser printer engine. The print engine 40 inputs the video data that has been output from the rasterize portion 30 and prints images onto paper.

Fig. 3 shows data structure of intermediate data. The intermediate data is configured of image source information, device information, and scaling information. The image source information includes data such as size

(number of bytes of image source information), bit depth, color specification, a number of pixels in a horizontal direction (widthwise direction), a number of pixels in a vertical direction (heightwise direction), and image data  
5 used as intermediate data (image data after enlargement or reduction) or intermediate image data. The device information includes data such as position at the device (x, y), width at the device, and height at the device. The scaling information includes a vertical-direction and a  
10 horizontal-direction expansion multiplier array.

The processing in the interpreter portion 20 is described below in more detail.

Fig. 4 is a flowchart of intermediate data generation processing by the interpreter portion 20. Note that the  
15 processing of Fig. 4 shows an example that does not include clip processing to be described later.

In S110, the interpreter portion 20 analyzes the PDL data that has been inputted from the host computer 2, and generates enlargement/reduction image data based on an image  
20 source size and a device image size included in the PDL data. Note that the image source size is a size of an image source, and the device image size is a size of a device image. The interpreter portion 20 also generates scaling information in the vertical direction and horizontal direction.

25 When the PDL data shown in Fig. 5(a) is inputted, for



example, the interpreter portion 20 analyses the PDL data and recognizes that the color specification is RGB, a direct image (direct color), with 24-bit color (8 bits for each of the RGB colors). The interpreter portion 20 also recognizes  
5 that the image source size is 100 pixels wide and 50 pixels high and that the device image size is 500 dots wide and 300 dots high.

The interpreter portion 20 then calculates and obtains the scaling information that specifies scaling  
10 (enlargement ratio) from the image source to the device image. The rasterize portion 30 uses the scaling information to enlarge the intermediate image data. The scaling information is array information of the number of pixels in the row direction and the number of pixels in the  
15 column direction in a pixel matrix. In an example of Fig. 6(a), 50 pixels in the heightwise direction (vertical direction) must be expanded to 300 dots. In this case, a scaling factor is obtained as  $300/50 = 6$ . Thus, each pixel is expanded to exactly six dots in the vertical direction.

20 As shown in Fig. 6(b), a vertical-direction expansion multiplier array is obtained as  $[50] = \{6, 6, 6, 6, 6, \dots, 6\}$ . Similarly, 100 pixels in the widthwise direction (horizontal direction) must be expanded to 500 dots. In this case, the scaling factor is obtained as  $500/100 = 5$ .  
25 Thus, each pixel is expanded to exactly five dots in the

horizontal direction. A horizontal-direction expansion multiplier array is therefore obtained as  $[100] = \{5, 5, 5, 5, 5, \dots, 5\}$ .

5 As shown in the example of Figs. 6(a) and 6(b), if the scaling factors in both of the vertical and horizontal directions are greater than 1, the CPU 21 stores the image data of the PDL data as is into the RAM 23 as the intermediate image data. Note that if the image data in the PDL data are compressed data, the CPU 21 decompresses the  
10 compressed data and stores the decompressed image data in the RAM 23.

Since the scaling factors in both the vertical and horizontal directions of this example are exactly divisible numbers (integers), the expansion multiplier arrays in both  
15 the vertical and horizontal directions are also integers as described above. Therefore, these integers can be used as is. If the scaling factor is not an integer, on the other hand, the expansion numbers for the pixels can be obtained as described below.

20 A method for obtaining the expansion multiplier array is described with reference to Figs. 7(a) and 7(b). Fig. 7(a) shows a general procedure to obtain the expansion multiplier array when expanding an image source size  $S$  to a device image size  $D$ . A basic idea of this method is to find  
25 how many  $S$  can be contained in  $D$ . In line 1, the device

image size D is assigned to a value DOTVALUE. A value Sn is 0. In line 2, the image source size S is subtracted from DOTVALUE. Assume DOTVALUE is still greater than S. The value Sn remains 0. In line 3, S is further subtracted from DOTVALUE. Assume DOTVALUE has become smaller than S after the subtraction. In this case, D is added to DOTVALUE and the value Sn is incremented from 0 to 1. In lines after line 3, the same calculation is performed.

A specific example of the above method is explained with reference to Fig. 7(b). In this example, an horizontal-direction expansion multiplier array is obtained when expanding a horizontal size 37 of the image source to a horizontal size 80 of the device image. In line 1, the horizontal size 80 of the device image is assigned to DOTVALUE. In line 2, the horizontal size 37 of the image source is subtracted from DOTVALUE ( $80-37=43$ ). DOTVALUE ( $=43$ ) is still greater than 37. The value Sn remains 0. In line 3, 37 is further subtracted from DOTVALUE ( $43-37=6$ ). Because DOTVALUE ( $=6$ ) has become smaller than 37, 80 is added to DOTVALUE ( $6+80=86$ ) and the value Sn is incremented from 0 to 1. In line 4, 37 is subtracted from DOTVALUE ( $86-37=49$ ). DOTVALUE ( $=49$ ) is still greater than 37. The value Sn remains 1. In line 5, 37 is further subtracted from DOTVALUE ( $49-37=12$ ). Because DOTVALUE ( $=12$ ) has become smaller than 37, 80 is added to DOTVALUE ( $12+80=92$ ) and the

value  $S_n$  is incremented from 1 to 2. The same procedure is repeated until the value  $D_n$  becomes 79 (the horizontal size of the device image 80 minus 1). As a result of this procedure, the values  $S_n$  and  $D_n$  are obtained as shown in Fig. 7(b), although Fig. 7(b) only shows the first 19 lines. The CPU 21 counts the numbers of each  $S_n$  with regard to  $D_n$ . That is, the CPU 21 counts how many 0s, how many 1s, how many 2s, and the like exist. In this example, the values  $S_n$  are 0, 0, 1, 1, 2, 2, 3, 3, 4, 4, 5, 5, 6, 6, 6, 7, 7, 8, 8..., where there are two 0s, two 1s, two 2s, ..., and so on. Accordingly, the CPU 21 obtains the horizontal-direction expansion multiplier array as  $[37] = \{2, 2, 2, 2, 2, 2, 3, 2, 2, \dots\}$ .

In another example, the image source size obtained by the PDL data is 500 pixels wide and 300 pixels high and that the device size is 700 dots wide and 800 dots high. In this case, the vertical-direction expansion multiplier array can be obtained as  $[300] = \{2, 3, 2, 3, 3, 2, 3, \dots\}$  and the horizontal-direction expansion multiplier array can be obtained as  $[500] = \{1, 1, 2, 1, 1, 2, 1, 2, 1, 1, \dots\}$ .

In some cases, at least one of the scaling factors in the vertical and horizontal directions is smaller than 1. In other words, the device image size is smaller than the image source size. In that case, the interpreter portion 20 performs reduction processing on the image data in the PDL data so that it fits into the device image size specified by

the PDL data (Fig. 5), and stores image data of the reduced size in the RAM 23. Note that if the image data in the PDL data is compressed data, the CPU 21 decompresses the compressed image data and performs the reduction processing  
5 on the decompressed image data.

The interpreter portion 20 performs the calculations to obtain the above-described scaling information after the reduction processing. If the scaling factor in the vertical direction is less than 1, all the elements of the vertical-  
10 direction expansion multiplier array are 1. Similarly, if the scaling factor in the horizontal direction is less than 1, all the elements of the horizontal-direction expansion multiplier array are 1. Note that, if one of the scaling  
15 factors in either the vertical or the horizontal direction is greater than 1, the scaling information is obtained, for the direction, by the scaling information processing for enlargement described above.

If the image source size obtained from the PDL data is 800 pixels wide and 700 pixels high and the device image  
20 size is 500 dots wide and 300 dots high, the scaling factors in both the horizontal and vertical directions are less than 1. Thus, the interpreter portion 20 reduces the image data in the PDL data into the device image size (500 dots wide and 300 dots high) and stores the reduced image data in the  
25 RAM 23. The interpreter portion 20 generates, as scaling

information, a vertical-direction expansion multiplier array [300] = {1, 1, 1, 1, ..., 1} and a horizontal-direction expansion multiplier array [500] = {1, 1, 1, 1, ..., 1}.

5 In S120 (Fig. 4), the interpreter portion 20 generates the image source information and device information in Fig. 3, based on the PDL data. Taking the PDL data of Fig. 5(a) as an example, the interpreter portion 20 stores, in the RAM 23, the bit depth of 8 bits, the color specification of RGB, and the vertical and horizontal sizes  
10 of image source of 100 and 50.

The interpreter portion 20 also stores, in the RAM 23, the device image position (600, 400), the device image size width (500 dots) and the device image size height (300 dots) in Fig. 5(a). These values correspond to the position at  
15 the device, the width at the device, and the height at the device, respectively, all of which are included in the device information (see Fig. 3).

In S150, the interpreter portion 20 determines whether or not the image data in the PDL data (image data of  
20 the image source) is 8-bit data. If the image data is 8-bit data (S150: YES), the CPU 21 advances to S180; if the image data is not 8-bit data (S150: NO), the CPU 21 moves on to S160.

In S160, the interpreter portion 20 determines  
25 whether or not the image size is excessively large. In

other words, the interpreter portion 20 determines whether or not the image size is greater than or equal to a predetermined value (such as 100 pixels high by 100 pixels wide). If the image size is greater than or equal to the  
5 predetermined value (S160: YES), the CPU 21 moves on to S180; if the image size is less than the predetermined value (S160: NO), the CPU 21 advances to S170.

In S170, the interpreter portion 20 converts each pixel of the post-enlargement/reduction image data into 8-  
10 bit format. The interpreter portion 20 also converts the value of the bit depth on the image source information (Fig. 3) created in S120 to 8-bit.

Thus, because of the processing of S160 through S180, the printer 1 can restrain the size of the image data used  
15 as intermediate data (intermediate image data) by not converting the pixel format to 8-bit if the image size is greater than or equal to the predetermined value.

If the PDL data includes data instructing rotation processing, such as a 90-degree, 180-degree, or 270-degree  
20 rotation, the CPU 21 performs rotation processing on the post-enlargement/reduction image data in S180.

In S190, the CPU 21 stores the image source information (including the intermediate image data), the device information, and the scaling information that are  
25 created in S110 through S180 in the RAM 23, as intermediate

data having the data structure shown in Fig. 3.

In S40 shown in Fig. 2, the rasterize portion 30 acquires intermediate data from the RAM 23 of the interpreter portion 20 through the I/O 24. Then, the  
5 rasterize portion 30 stores device multivalue page data based on the intermediate data into the drawing memory 32. The rasterize portion 30 performs this storing (drawing) processing based on the information in the intermediate data shown in Fig. 3. The rasterize portion 30 references the  
10 bit depth, and if the bit depth is 1-bit, 2-bits, or 4-bits, the rasterize portion 30 stores or draws the image data in the drawing memory 32 while converting the image data into 8-bit format. The rasterize portion 30 also references the scaling information and performs the storing (drawing)  
15 processing while expanding each pixel, based on an expansion multiplier number in the vertical-direction expansion multiplier array corresponding to that pixel and the expansion multiplier number in the horizontal-direction expansion multiplier array corresponding to that pixel. In  
20 an example shown in Fig. 6(b), for example, the rasterize portion 30 expands each pixel into data for 5 dots in the horizontal direction and 6 dots in the vertical direction.

As described above, the page data in the drawing memory 32 is subjected to UCRGCR (under color removal and  
25 gray component replacement) processing to adjust the black



level thereof (S50). The page data is subsequently binarized through half-tone processing according to well-known dither method (S60). Then, the rasterize portion 30 outputs video data to the print engine 40 based on the processed data. The print engine 40 receives the video data that is outputted from the rasterize portion 30 and prints the video data on paper.

As described above, if enlargement is required, the printer 1 uses the image data before the enlargement processing as the intermediate data; and if reduction is required, the printer 1 uses the image data after the reduction processing as the intermediate data. This enables the printer 1 to reduce the amount of memory (the RAM 23) used for storing the intermediate data. In other words, it makes it possible to restrain any inflation of the intermediate data and suppress pressure on the memory.

Note that processing in S150 through S170 in Fig. 4 ensure that the interpreter portion 20 converts the image data into 8-bit data if the image size is less than the predetermined value. However, as shown in Fig. 5(b), if the PDL data supports a format given in index values for a color palette, and the size of the image data is less than the predetermined value, the interpreter portion 20 can perform conversion of the pixel format into color data (direct colors). When the interpreter portion 20 has performed

conversion into color data, the value of the color specification of the image source information (Fig. 3) created in S120 will be changed from "palette" to "RGB".

5 If the color specification is other than "RGB" in such a case, the rasterize portion 30 stores the intermediate image data into the drawing memory 32 while converting the pixel format into "RGB". Hence, the printer 1 can minimize the intermediate data and thus suppress any pressure on the memory (the RAM 23). As shown in the  
10 example in Fig. 5(b), since direct image (RGB) data is 24 bits (8 bits for each of the RGB colors) in contrast to the 8-bit palette data, storing the 8-bit palette data as intermediate data requires only one-third of the volume of the drawing memory 32.

15 If the PDL data supports a function called a clip command, the interpreter portion 20 can also perform clip processing in the processing of S110 in Fig. 4.

The interpreter portion 20 performs the clip processing when the host computer 2 has sent the clip command shown in Fig. 5(c) together with the PDL data of Fig. 5(a).  
20

In S110, the CPU 21 calculates a corresponding relationship from the PDL data of Figs. 5(a) and 5(c). Figs. 8(a) through 8(d) show how the interpreter portion 20 performs the clip processing. Fig. 8(a) shows an image  
25

source S having an image source size of 100 pixels wide by 50 pixels high (Fig. 5(a)) which will be enlarged by the interpreter portion 20.

As shown in Fig. 8(b), the interpreter portion 20  
5 enlarges the image source S in the area of a device image size (500 dots wide by 300 dots high) at the position of the device image (Fig. 5(a)) that starts at a point C(600, 400) within a device page area that is equivalent to the paper. The interpreter portion 20 obtains a drawing area R1 (the  
10 shaded portion in Fig. 8(b)) that is positioned inside a clip rectangle. The clip rectangle is defined by a diagonal line between a point A(800, 300) and a point B(1300, 550) that is specified by the clip command in Fig. 5(c). As shown in Fig. 8(b), the drawing area R1 is inside a  
15 rectangle defined by a diagonal line between a point D(800, 400) and a point E(1100, 550) in the device page area.

As shown in Fig. 8(c), the interpreter portion 20 obtains a corresponding image source area R2 of the image source S that corresponds to the drawing area R1. The  
20 corresponding image source area R2 is an area of the shaded portion in Fig. 8(c) that is inside a rectangle defined by a diagonal line between a point F(40, 0) and a point G(100, 25). Then, the interpreter portion 20 cuts out or clips only the corresponding image source area R2 and obtains the  
25 image source after clipping that is shown in Fig. 8(d).

As shown in Fig. 9, the CPU 21 expands one line of data in the horizontal direction from a receive buffer for the PDL data that is provided in the RAM 23. The CPU 21 clips only data for horizontal positions within the area R2 (the shaded portion) from a line in the image source S. Then, the CPU 21 writes the data for the clipped portion to the RAM 23. The CPU 21 generates the image data for the clipped portion by repeating this processing one line at a time.

10       The CPU 21 then performs the previously described enlargement/reduction processing on the clipped image data, to obtain post-enlargement/reduction image data (intermediate image data). Note that if reduction is to be performed, the interpreter portion 20 performs the reduction during the clip processing. Since the clip processing throws away the image data that is not used for actual printing, only the necessary portions are generated as intermediate image data. It is therefore possible to further reduce the volume of intermediate data, enabling a further suppression of pressure on the memory.

20       The interpreter portion 20 can also perform a processing that is similar to the clip processing described above. In an example shown in Fig. 10(a), a device image does not fit in the device page area and includes an outside area D0 that is outside the device page area. In such a

case, as shown in Fig. 10(b), the CPU 21 finds an inside area S1 of the image source that corresponds to an inside area D1 of the device image. Then, the interpreter portion 20 generates the intermediate data including image data of the inside area S1 of the image source. Other than that, the interpreter portion 20 performs processing similar to the clip processing described above.

According to the printer 1 of the present embodiment as described above, because the rasterize portion 30 need not calculate whether each pixel of the image source is to be expanded to some dots of the device image, the configuration of the rasterize portion 30 can be simplified.

The printer 1 uses the image data of the image source itself as the intermediate image data when enlargement is required from the image source size to the device image size. Further, the interpreter portion 20 converts the pixel format to the format that is required by the rasterize portion 30, only when the image source size is smaller than a predetermined size. Accordingly, there is no problem that the size of the intermediate data becomes too large.

While the invention has been described in detail with reference to the specific embodiment thereof, it would be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention.